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Supplementary Information to accompany:

Spatially Resolved Optical Emission and Modelling Studies of Microwave-Activated Hydrogen Plasmas Operating under Conditions Relevant for Diamond Chemical Vapor Deposition

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Figure S1

(a) $I_{\text{em}}(\lambda, z)$ Image (where $z = 0$ defines the substrate surface) in the wavelength range 423-497 nm from a hydrogen plasma operating under base conditions: $p = 150$ Torr, $P = 1.5$ kW, $F(\text{H}_2) = 300$ sccm, $d_{\text{sub}} = 32$ mm and $d_{\text{wire}} = 0.01$ ". The strong lines at 434.0 nm and 486.1 nm are the H Balmer- γ and Balmer- β emissions. (b) $I_{\text{em}}(\lambda)$ plot of the summed emission intensities in the height range $3 \leq z \leq 6$ mm over the wavelength range $448 \leq \lambda \leq 465$ nm, with R branch lines of the G-B (0,0) band identified.

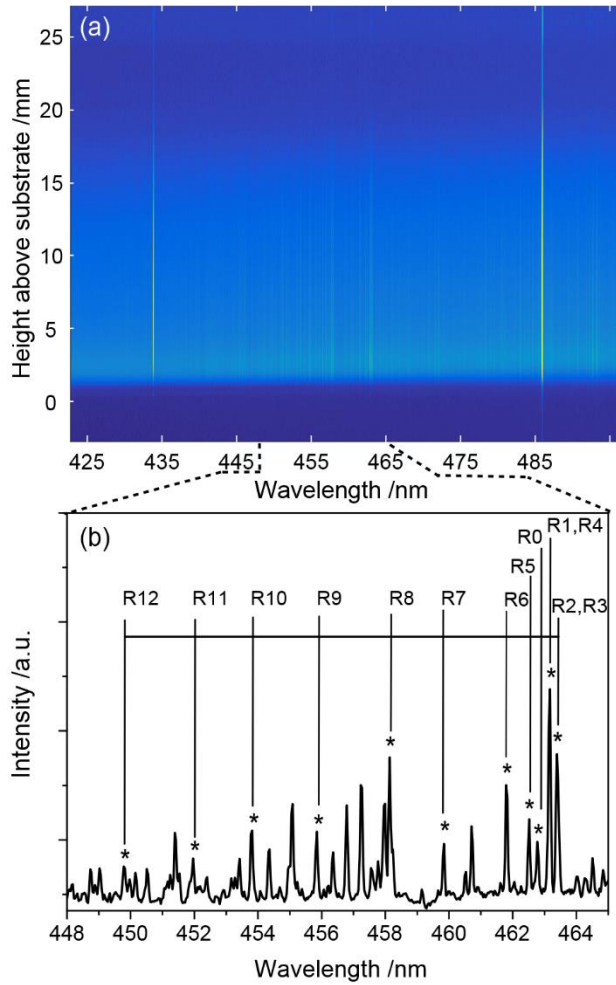


Figure S2

(a) $I_{\text{em}}(\lambda, z)$ image (where $z = 0$ defines the substrate surface) in the wavelength range 563-636 nm from a hydrogen plasma operating under base conditions: $p = 150$ Torr, $P = 1.5$ kW, $F(\text{H}_2) = 300$ sccm, $d_{\text{sub}} = 32$ mm and $d_{\text{wire}} = 0.01$ ". (b) $I_{\text{em}}(\lambda)$ plot of the summed emission intensities in the height range $3 \leq z \leq 6$ mm over the range $600 \leq \lambda \leq 620$ nm, with the utilised H_2 d-a (0,0) Q branch lines identified.

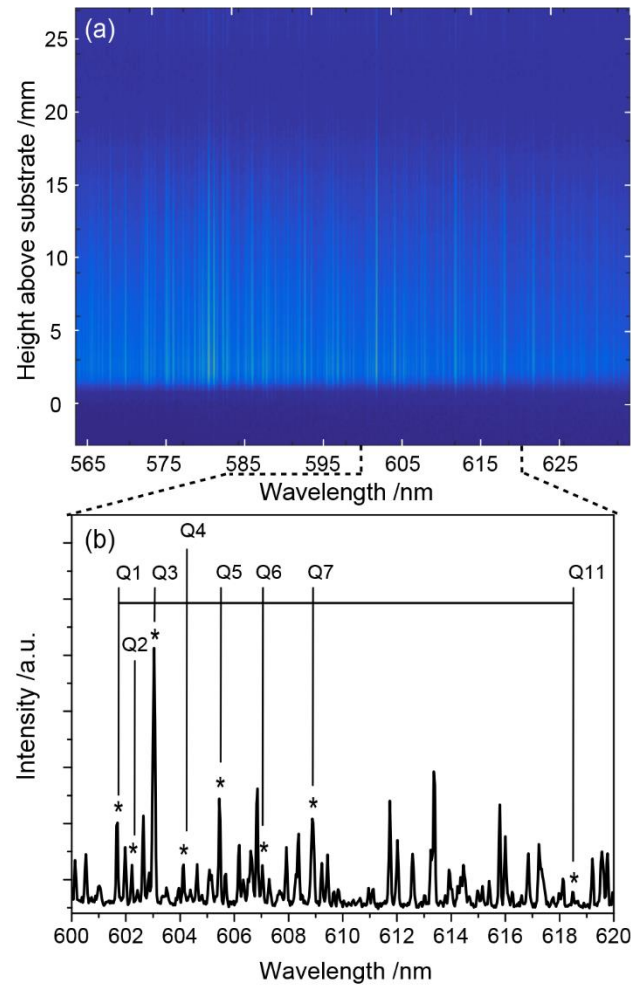


Figure S3

Spatial profiles of (a) $I_{\text{em}}(\text{H}_2^*, \text{d-a})$ emission and (b) $I_{\text{em}}(\text{H}_\alpha)$ emission for a MW activated hydrogen plasma operating at three pressures with a substrate diameter $d_{\text{sub}} = 17 \text{ mm}$, $d_{\text{wire}} = 0.004''$ and $P = 0.9 \text{ kW}$. The relative intensities in any given plot are displayed on a common vertical scale. Tilt view images of the plasma above the substrate (indicated by the ellipse superposed on the $p = 275 \text{ Torr}$ image), aperture by the slot shaped viewing port, are shown in the inset in (b). The T_{sub} values at all three pressures were below our detection limit.

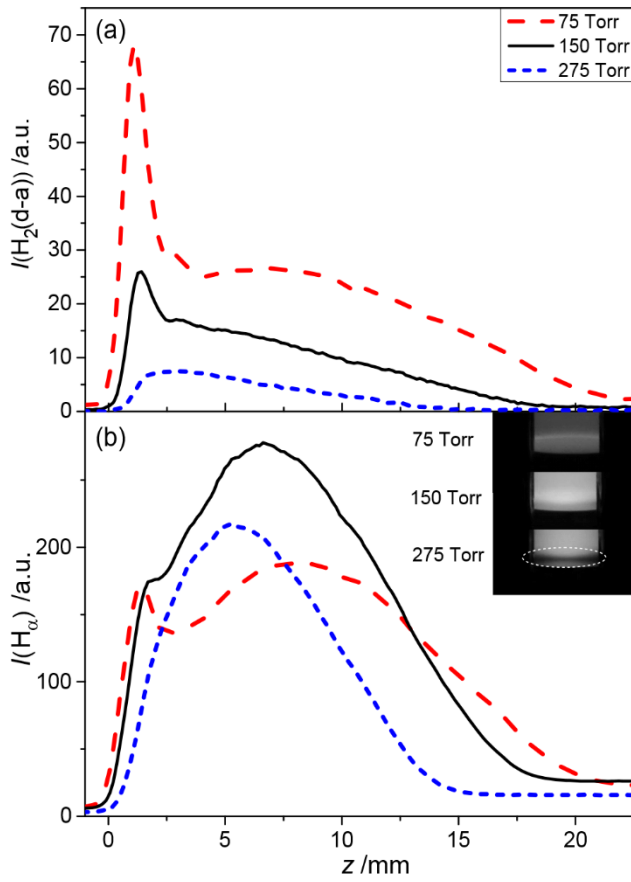


Figure S4

Spatial profiles of (a) $I_{\text{em}}(\text{H}_2^*, \text{d-a})$ emission and (b) $I_{\text{em}}(\text{H}_\alpha)$ emission from a MW activated hydrogen plasma operating at three pressures with a substrate diameter $d_{\text{sub}} = 17$ mm, $d_{\text{wire}} = 0.004$ ", and $P = 1.85$ kW. The relative intensities in any given plot are displayed on a common vertical scale. The inset in (b) shows tilt view images of the plasma above the substrate, apertured by the slot shaped viewing port. The measured T_{sub} values are, respectively, below detection limit, 1020 °C and 1070 °C for $p = 75$ Torr (red), 150 Torr (black) and 275 Torr (blue).

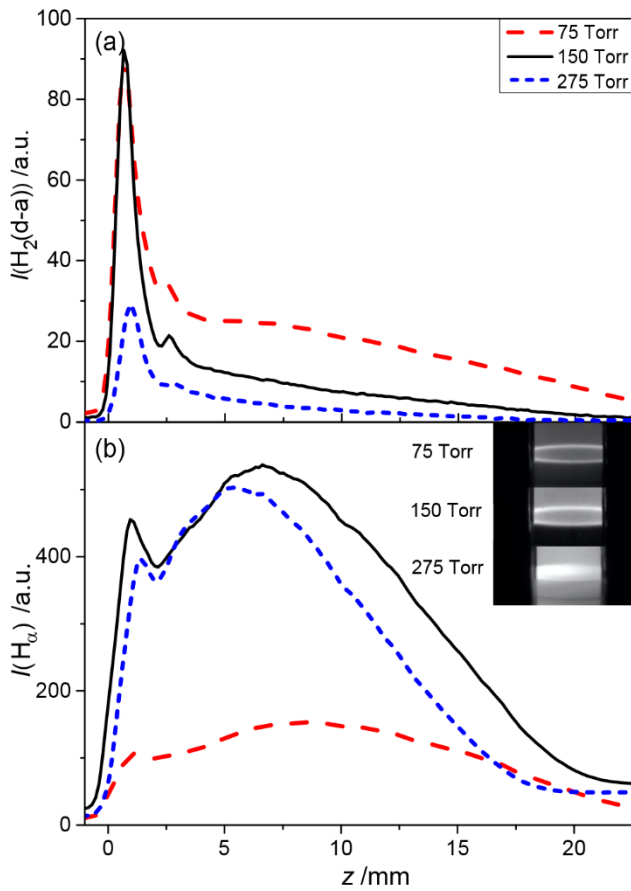


Figure S5

Calculated (a) axial (z , $r = 0$) and (b) radial ($z = 10.5$ mm, r) distributions of T_g , T_e and T_{tail} (left hand axis) and the average absorbed MW power density $|jE|$, and electric $|E|$ and reduced electric $|E|/(N \times a)$ fields (right hand axis) for $d_{\text{sub}} = 18$ mm and base conditions of p and P .

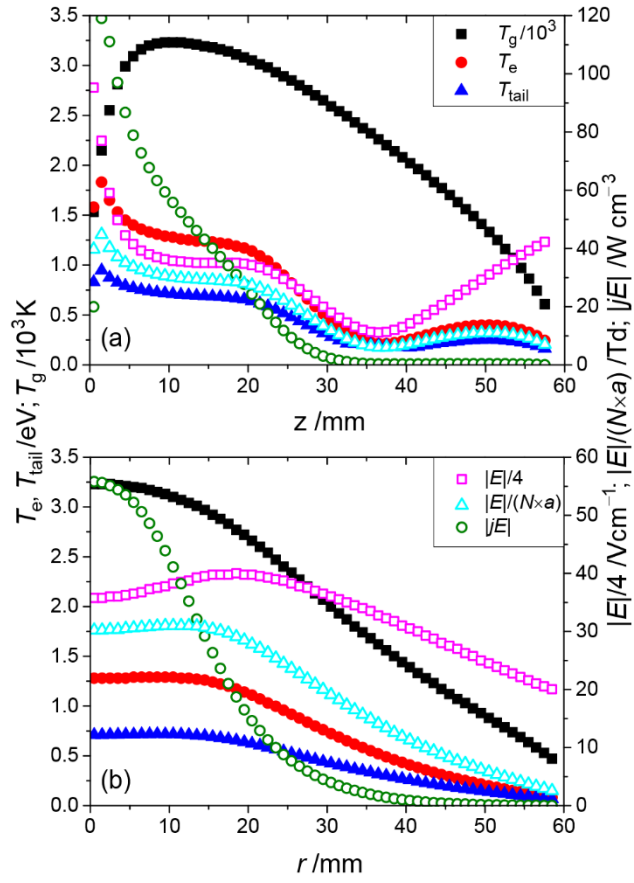


Figure S6

Calculated axial (z , $r = 0$) concentration distributions of (a) $H(n = 1, 2, 3)$ atoms, (b) the dominant charged species and (c) the ground and selected excited states of H_2 for $d_{\text{sub}} = 18$ mm and base conditions of p and P . Note that the distributions in (a) and (c) are plotted on a logarithmic scale.

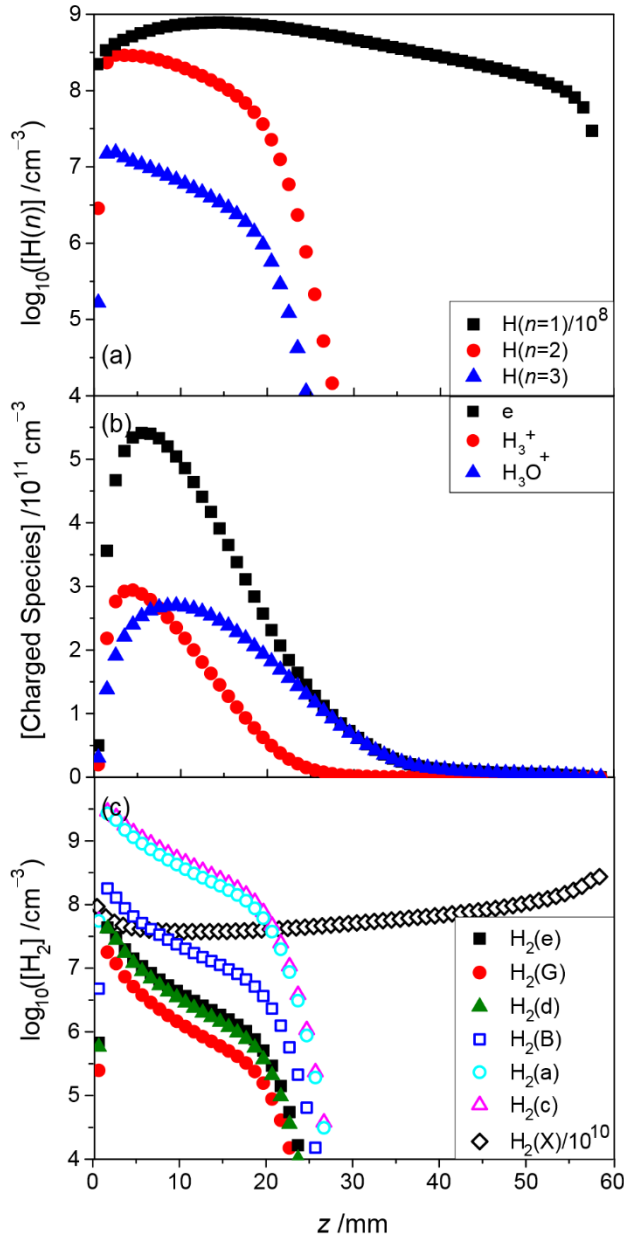


Figure S7

Calculated radial ($z = 10.5$ mm, r) concentration distributions of (a) $H(n = 1, 2, 3)$ atoms, (b) the dominant charged species and (c) the ground and selected excited states of H_2 for $d_{\text{sub}} = 18$ mm and base conditions of p and P . Note that the distributions in (a) and (c) are plotted on a logarithmic scale.

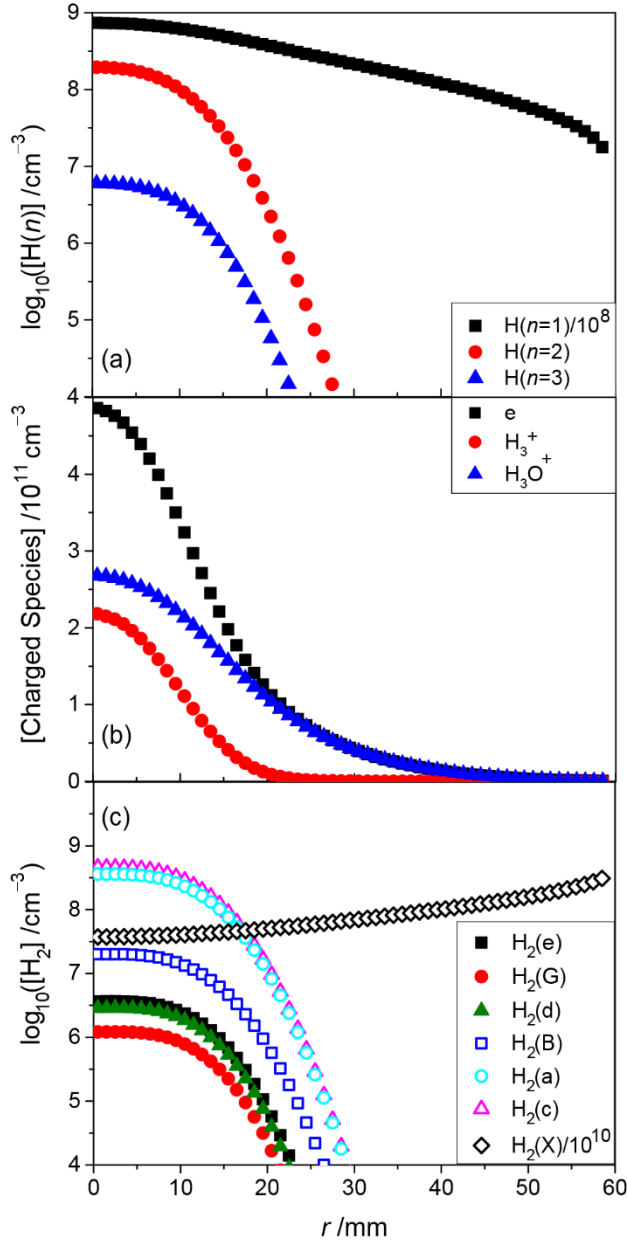


Figure S8

Comparisons of the calculated column densities (symbols) and measured emission intensities (lines) of (a) $\text{H}_2(\text{G}, v=0)$ and (b) $\text{H}_2(\text{d}, v=0)$ molecules for $p = 75$ Torr (red), 150 Torr (black) and 250 Torr (blue), with $P = 1.5$ kW and $d_{\text{sub}} = 32$ mm.

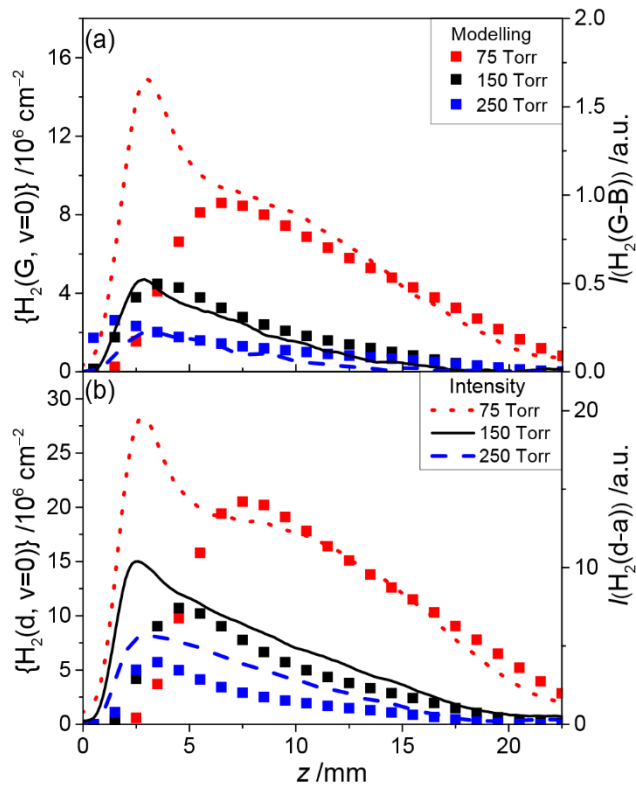


Figure S9

Comparisons of the calculated column densities (symbols) and measured emission intensities (lines) of (a) $\text{H}_2(d, v=0)$ and (b) $\text{H}(n=3)$ atoms for $d_{\text{sub}} = 17(18)$ mm (in the experiment (in the modelling), in red) and $d_{\text{sub}} = 32$ mm (black), with $P = 1.5$ kW, $p = 150$ Torr and $d_{\text{wire}} = 0.01''$.

